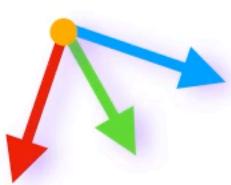
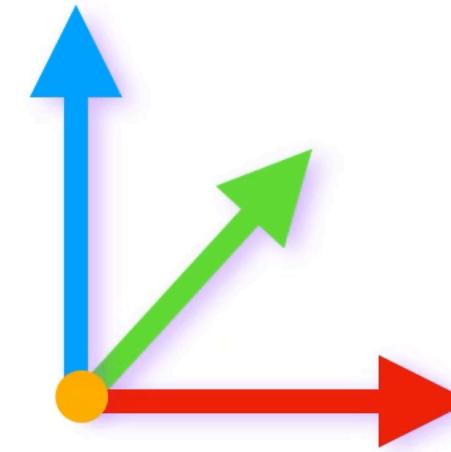
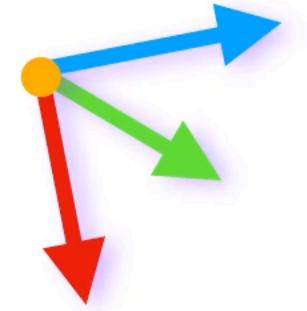
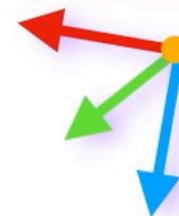


DR



DeepRob

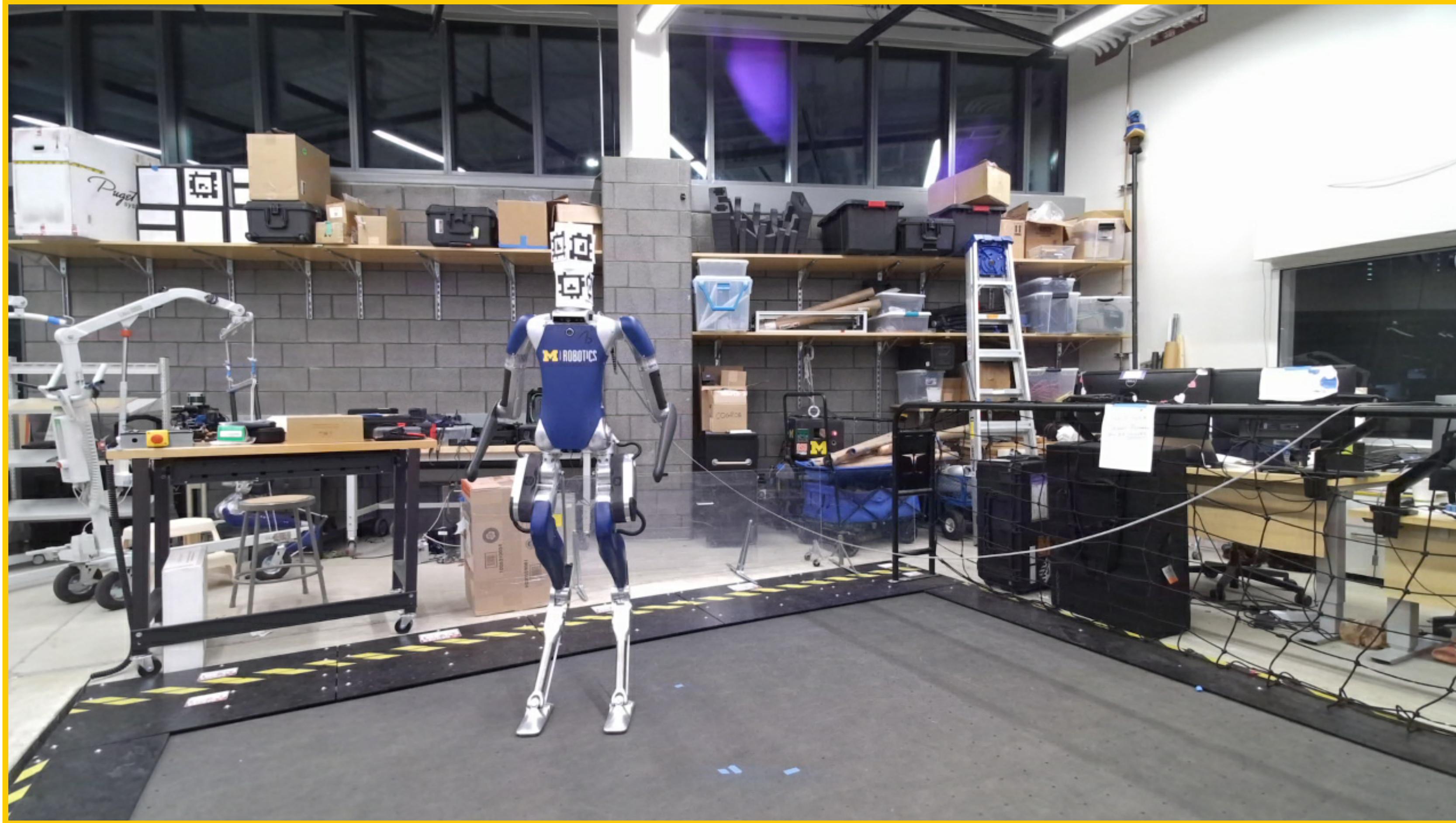
Discussion 9
Prelude to Object Tracking
University of Michigan and University of Minnesota



Next Time: Object Tracking

- Seminar 5: Recurrent Networks and Object Tracking
 1. [DeepIM: Deep Iterative Matching for 6D Pose Estimation](#), Li et al., 2018
 2. [PoseRBPF: A Rao-Blackwellized Particle Filter for 6D Object Pose Tracking](#), Deng et al., 2019
 3. [6-PACK: Category-level 6D Pose Tracker with Anchor-Based Keypoints](#), Wang et al., 2020
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- Seminar 6: Visual Odometry and Localization
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 4. [Differentiable SLAM-net: Learning Particle SLAM for Visual Navigation](#), Karkus et al., 2021

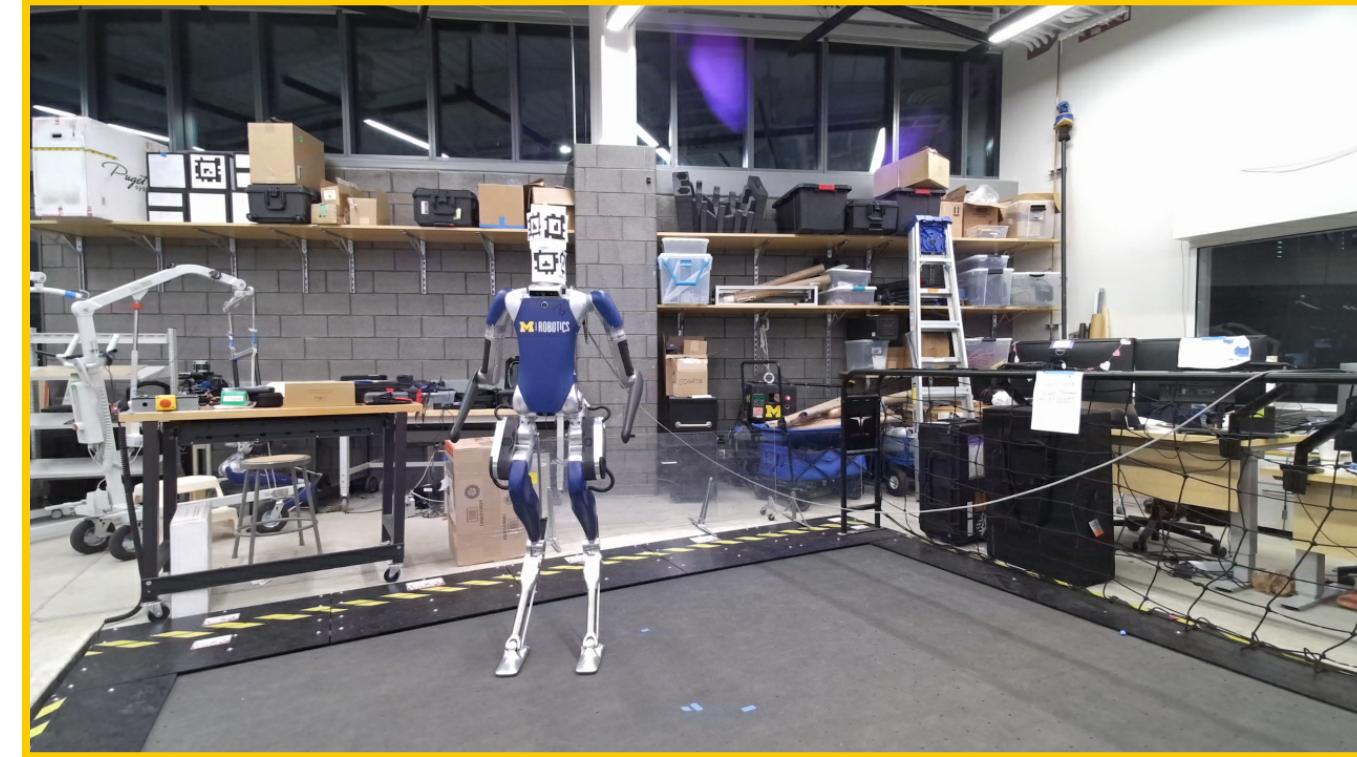
Last Time: Rigid Body Objects



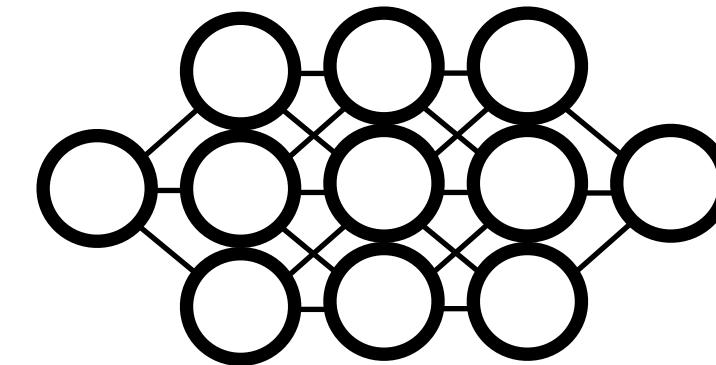
Data courtesy of [Anthony Opiari](#), [Liz Olson](#), [Grant Gibson](#), and [Arden Knoll](#)

Last Time: Rigid Body Objects

Image



Deep Network

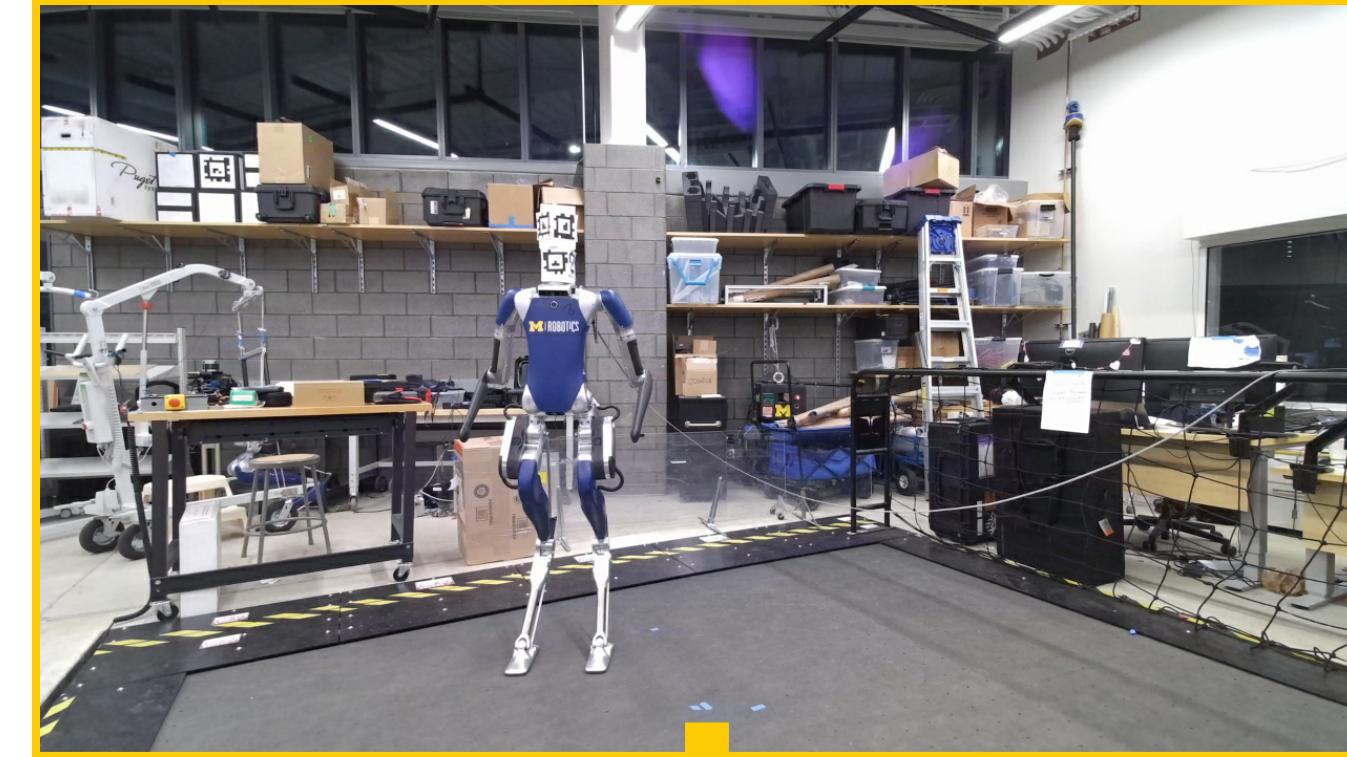


Object Representation

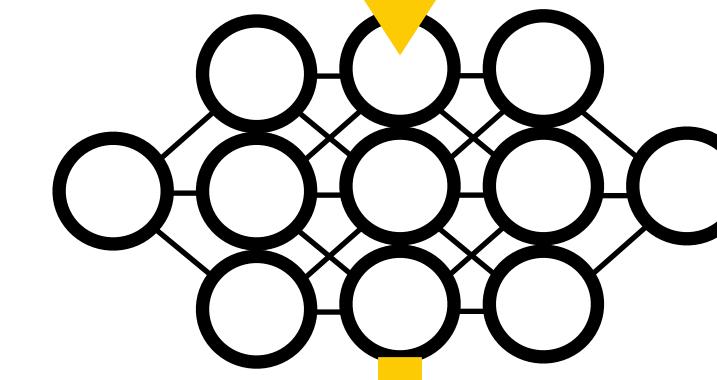


Extending Deep Learning to Sequences

Image



Deep Network



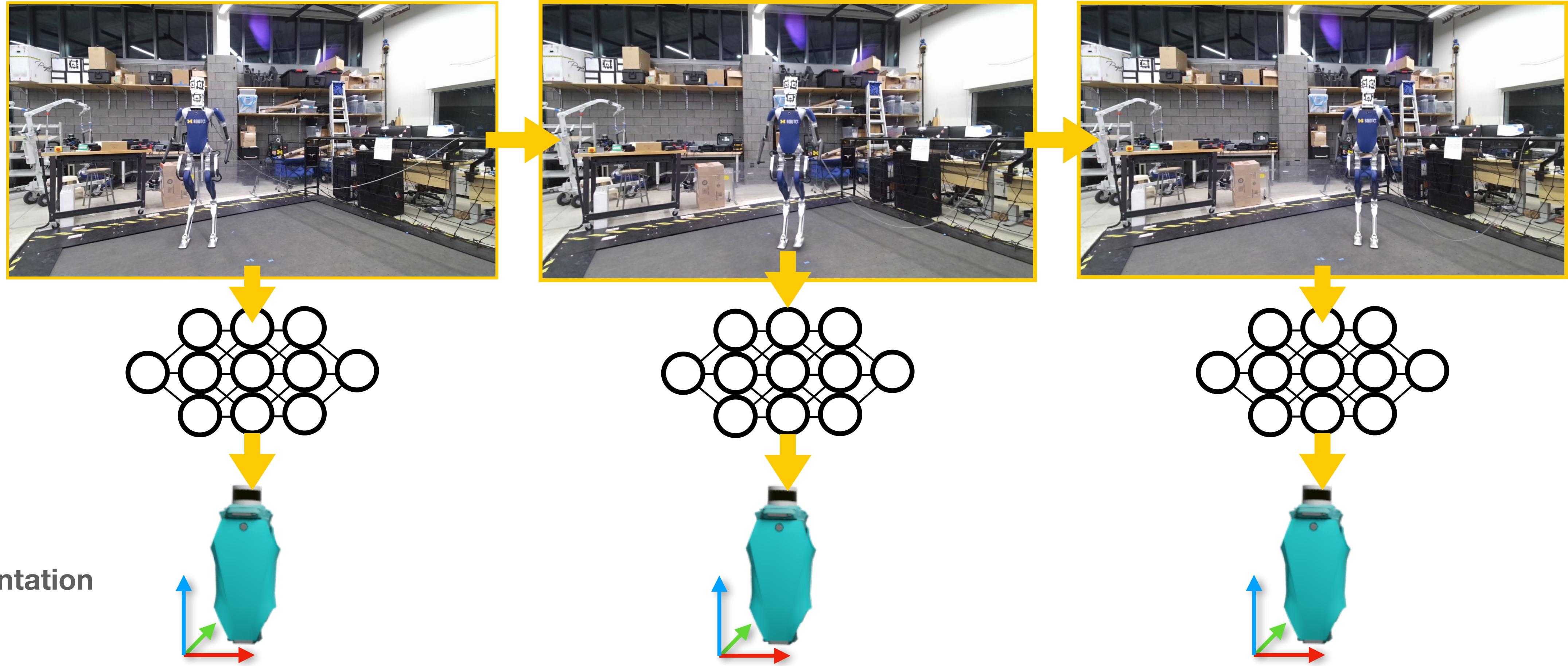
Object Representation



Data courtesy of [Anthony Opiari](#), [Liz Olson](#), [Grant Gibson](#), and [Arden Knoll](#)

Extending Deep Learning to Sequences

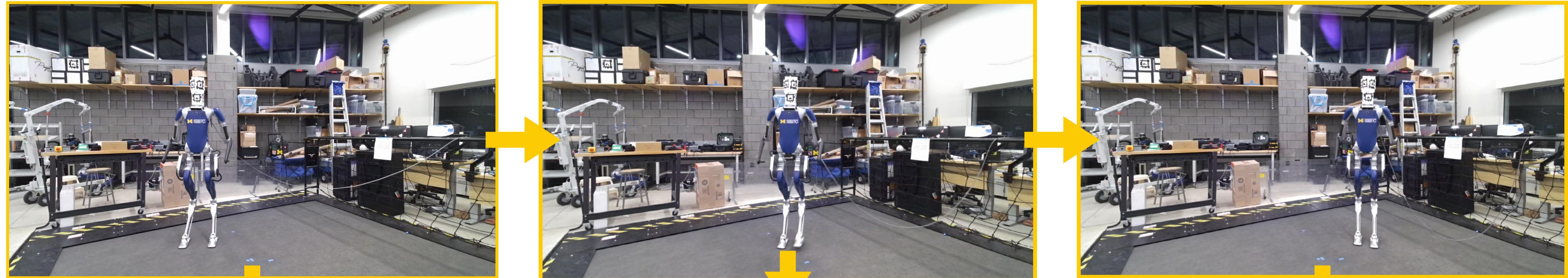
Image



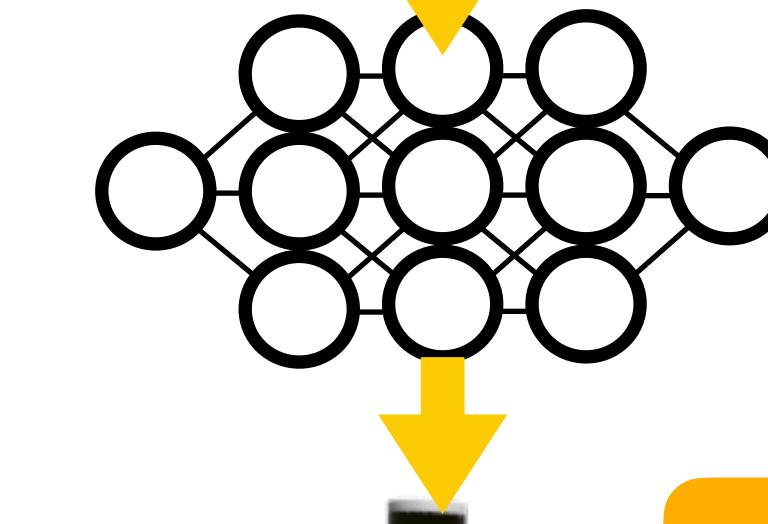
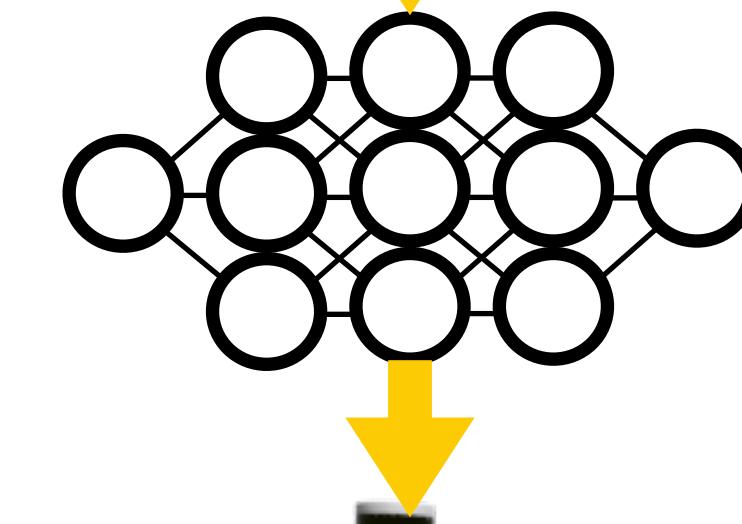
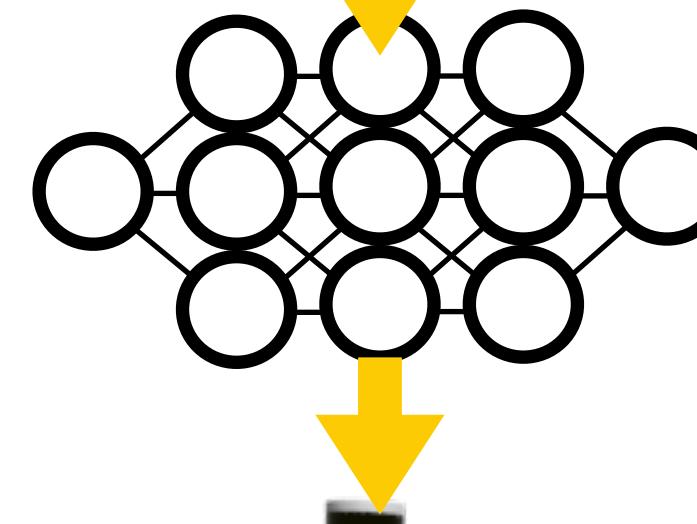
Data courtesy of [Anthony Opiari](#), [Liz Olson](#), [Grant Gibson](#), and [Arden Knoll](#)

Idea #1: Frame-by-Frame Estimation

Image



Deep Network



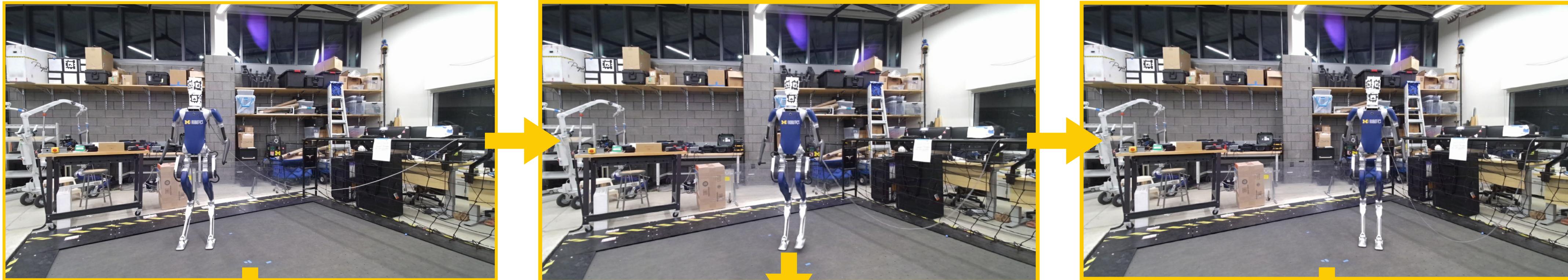
Object Representation



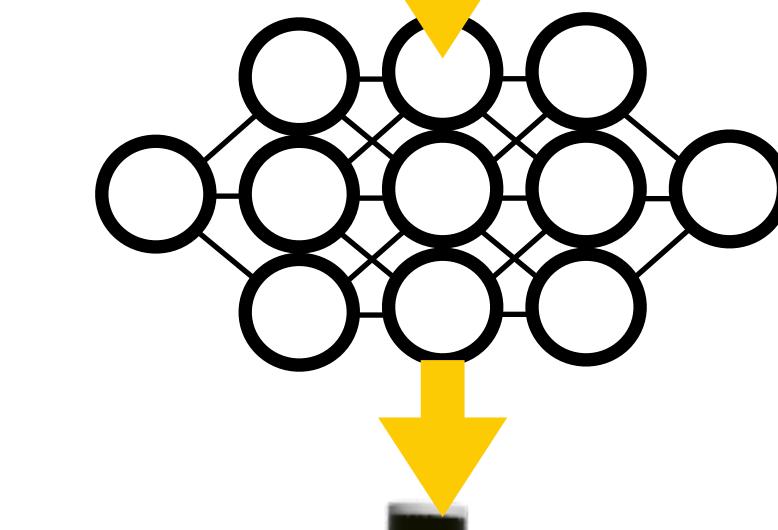
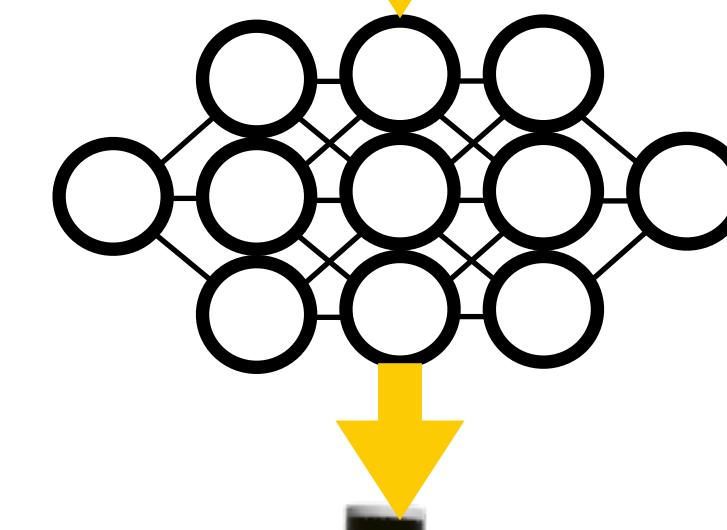
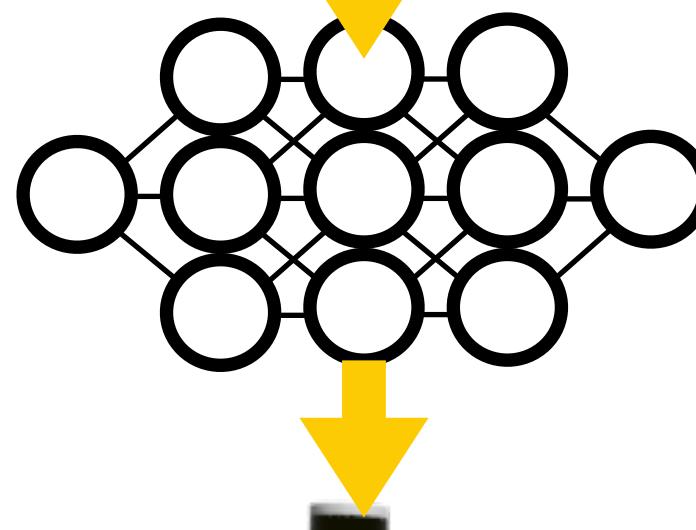
No Fusion!
Limitation: Model ignores trajectory information

Idea #2: Filter Network Outputs

Image



Deep Network



Object Representation



Filtering Algorithm

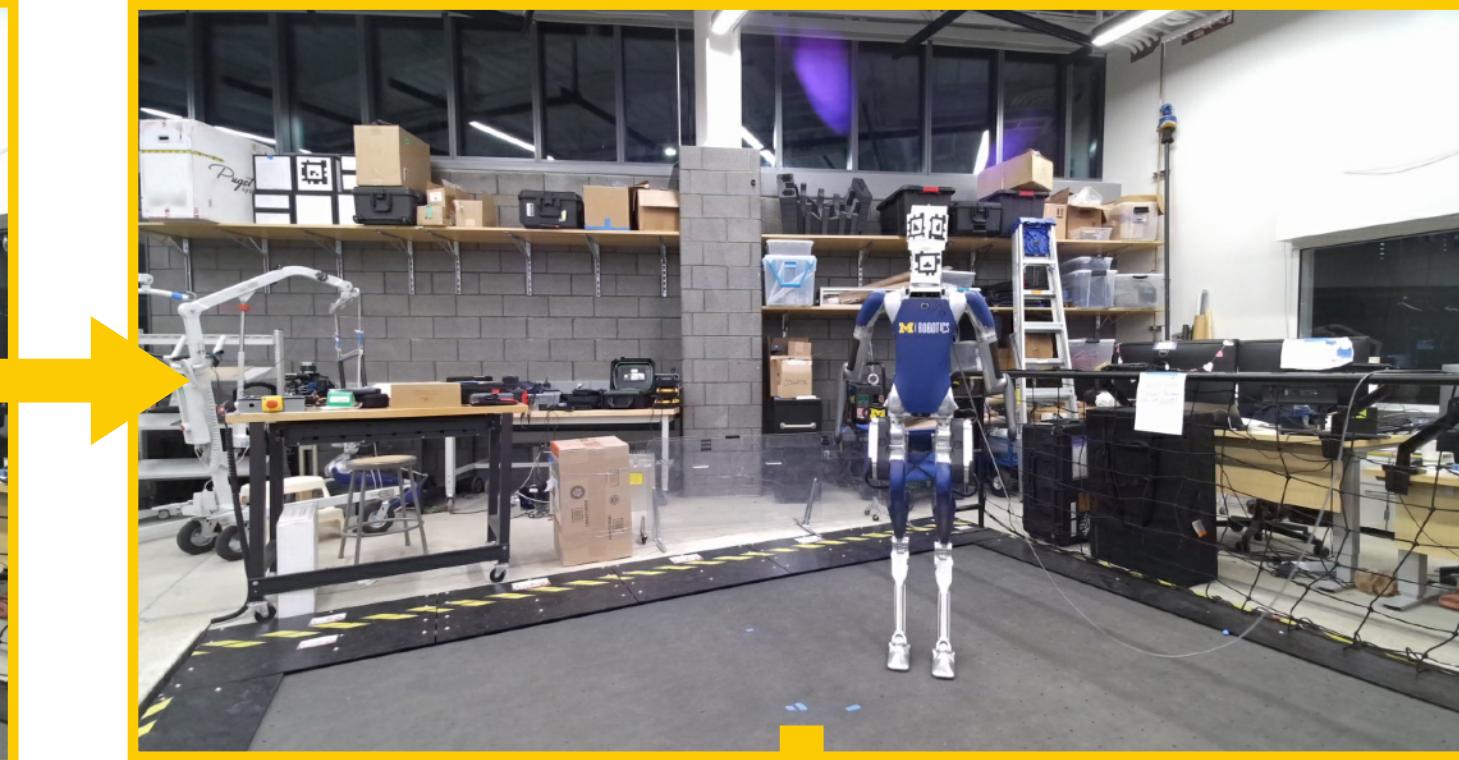
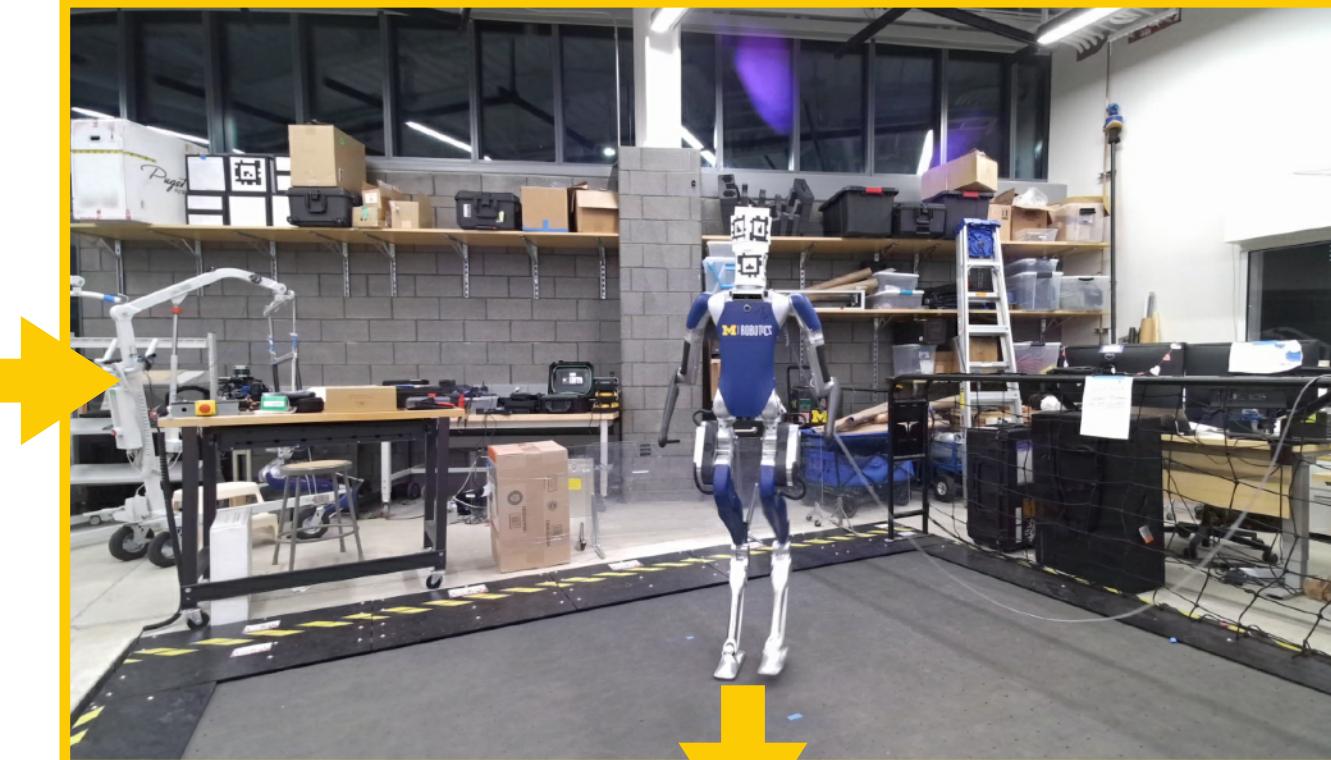
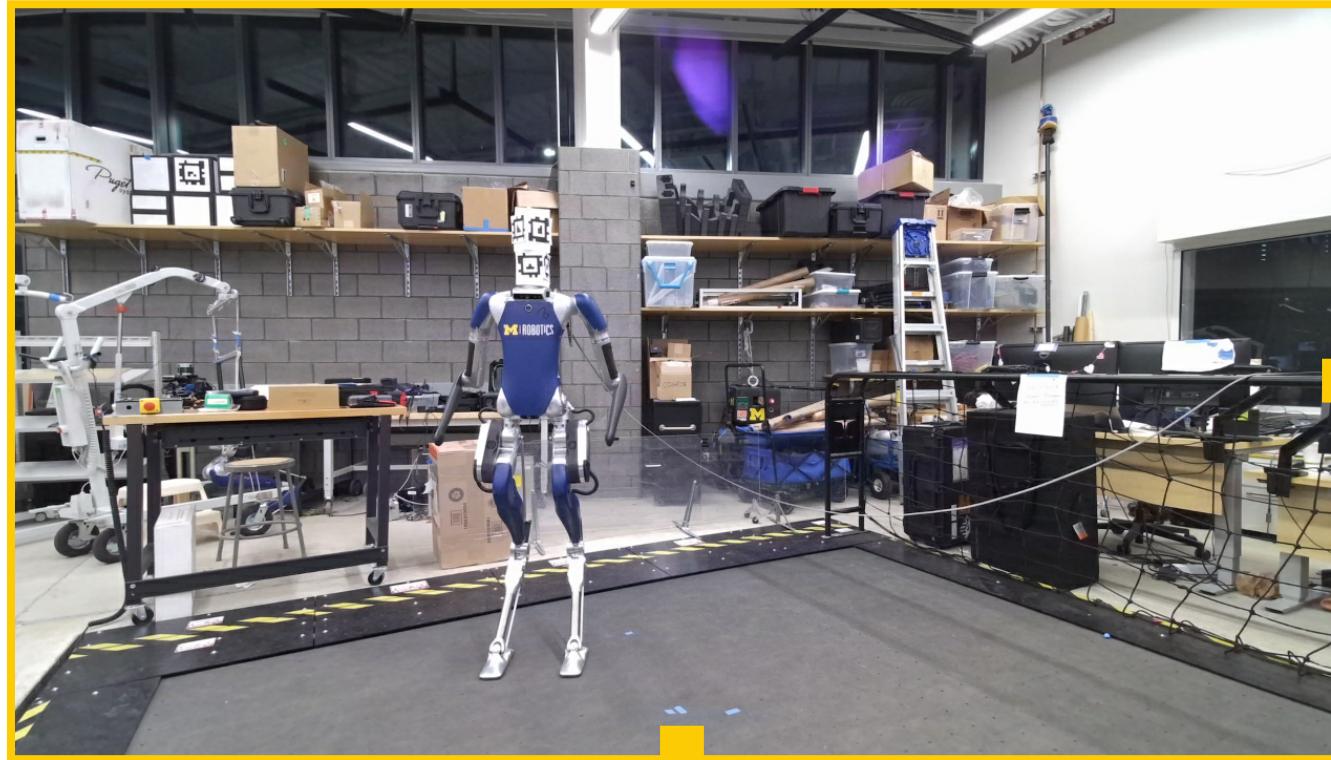


Filtering Algorithm

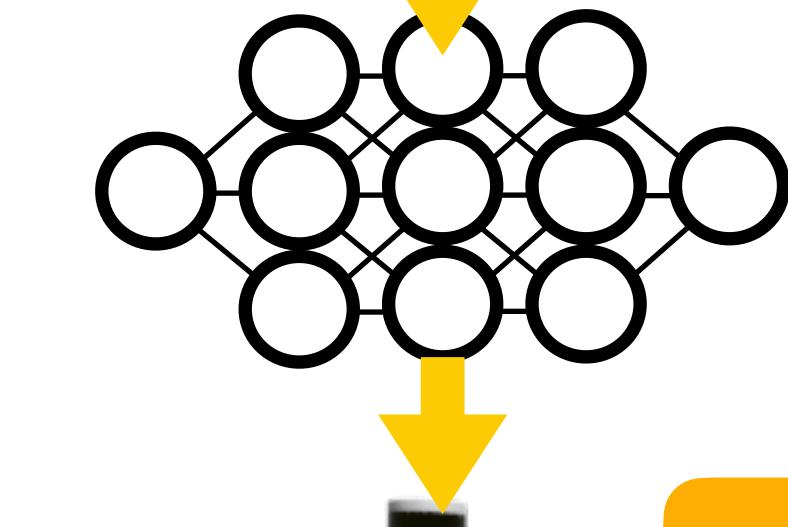
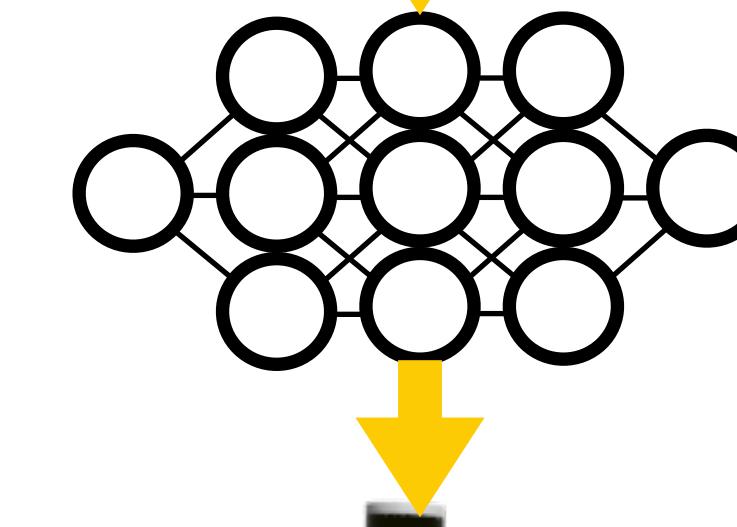
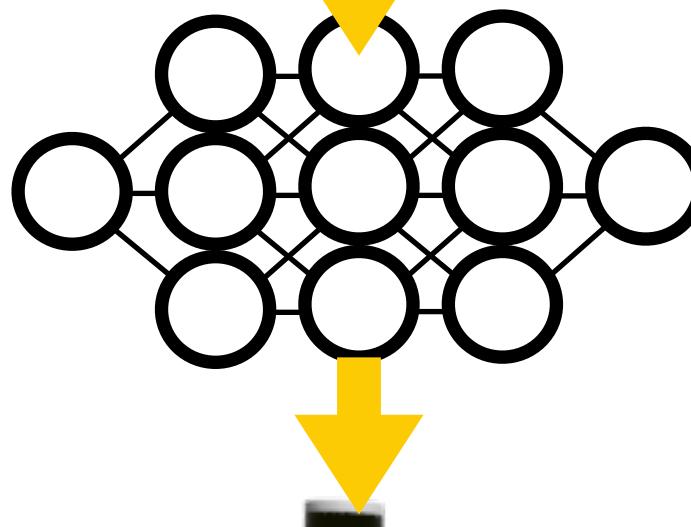


Idea #2: Filter Network Outputs

Image



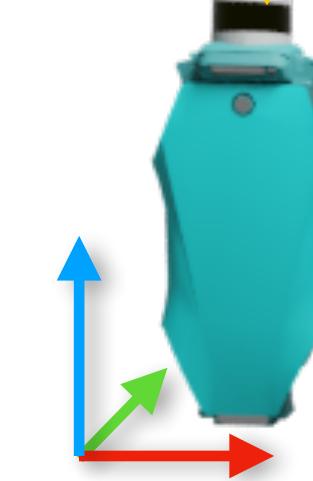
Deep Network



Object Representation



Filtering Algorithm



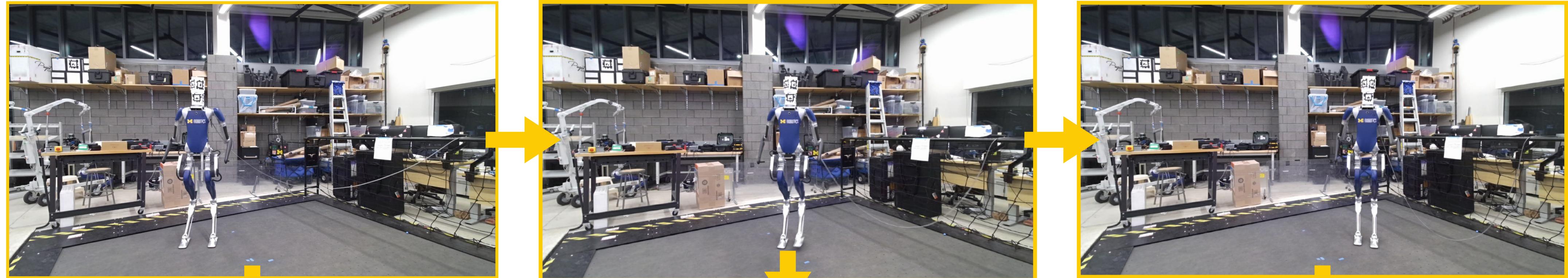
Filtering Algorithm



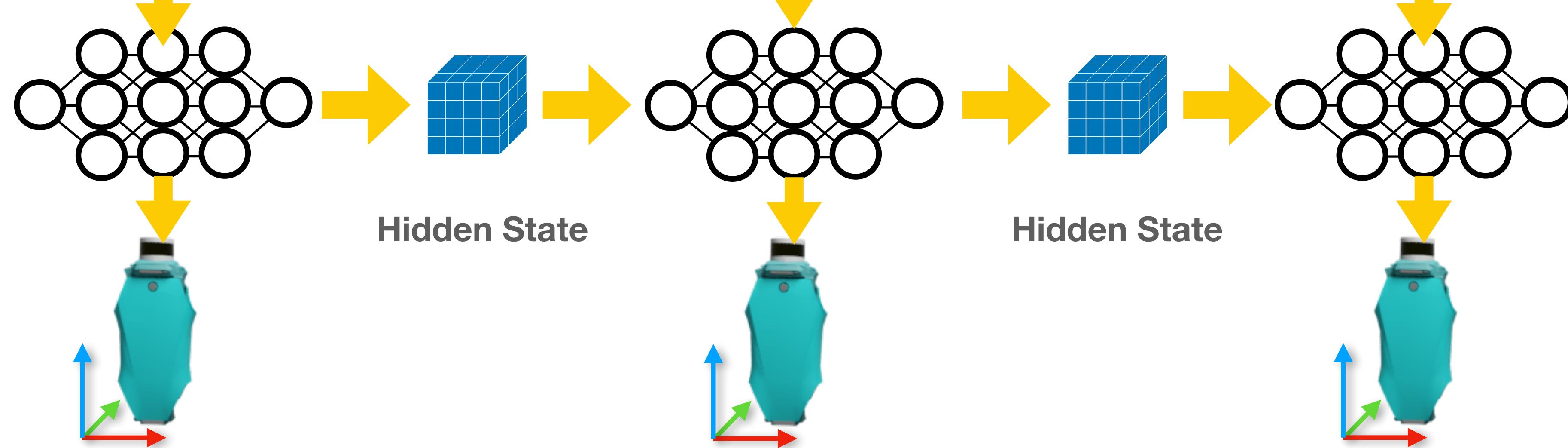
Late Fusion!
Limitation: Fusion depends on final state representation

Idea #3: Recurrent Networks

Image



Deep Network



Object Representation

Data courtesy of [Anthony Opiari](#), [Liz Olson](#), [Grant Gibson](#), and [Arden Knoll](#)

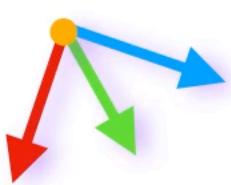
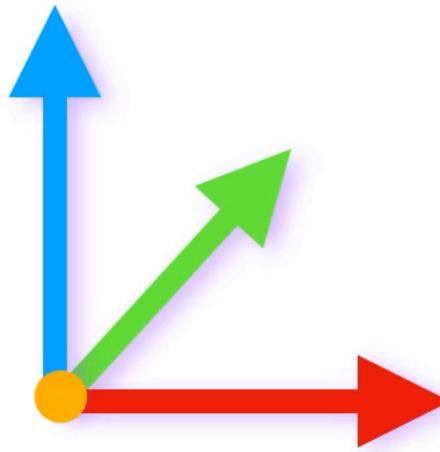
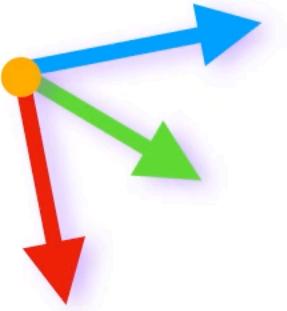
Object Tracking: Roles for Recurrent Networks

- 6DoF pose tracking
 - How to track the position and orientation of objects?
- Articulated human and robot pose tracking
 - How to track an object that is deformable or has known structure?
- Recurrent networks for robot odometry
 - How to use recurrent networks to model robot position over time?
- Recurrent networks for SLAM
 - How to localize and map a robot's environment with recurrent networks?

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Discussion 9

Prelude to Object Tracking

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